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Apparatus and Method for the Laying of Elongate Articles

This invention relates to apparatus and a method for the laying of elongate articles, and in particular, to a method and apparatus for sub-sea laying of elongate articles such as flexible pipes, umbilical pipes and cables.

Currently two methods are used for the sub-sea laying of flexible pipes etc. on the seabed. The most commonly adopted method is a horizontal system in which the suspended pipe forms a catenary between the seabed and the vessel and is brought inboard over a wheel, roller or chute of a large diameter compared to the pipe diameter. One or more tracked (or "caterpillar") tensioners and a winch are deployed along the deck of a vessel. The lay load from the elongate article being laid can then be transferred in a straightforward manner from the tensioner to the winch.

Flexible pipes etc. are normally laid in sections with end connections provided for joining up of the sections to form the pipeline. Therefore, it is important that the end connection can be passed through the tensioners without damage to either. The provision of a winch aligned with the axis or axes of the tensioners enables the lay load to be transferred to the winch, so that the tensioners in a horizontal arrangement can be opened to allow for the passage of the end connections. A frame or a wheel may also be provided to enable the passage of the end connection over the side of the vessel without bending it and risking damaging it. The end connection may then be hung off and a second pipe section connected to it and laying of the pipeline restarted.

The drawbacks with this horizontal system revolve around the fact that the system occupies a great length and amount of space on the deck of the vessel. In practice, this means that deployment of the pipe is over the stern of the vessel where movement of the vessel is at its most and so the risk of damage to the article or the end connection is at its greatest. Even in the best conditions crushing type loads are inevitably applied to the pipe as it bends over the stern of the vessel, which effectively limits the depth to which the pipe and the pipeline can be laid.

In the second method, a tower is used with a tensioner and winch mounted vertically over a work platform. This removes the need for the frame or the wheel as deployment can be straight from the deck. This vertical system is relatively compact with regard to deck space and can be used to lay pipe through a moonpool, if provided on the vessel.

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EP-A-0478742 discloses one particular arrangement for a vertical lay system. In this system a tower is vertically disposed and straddles the moonpool of a vessel. The pipe being laid is passed straight down through the tower and down through the centre of the moonpool to the sea-bed. The tensioner is the last point of guidance for the pipe before  
10 it enters the water so that the pipe is not bent while under tension. In this manner crushing loads are avoided on the part of the pipe under tension. Space occupied on deck is also reduced.

Whilst the vertical type systems carry advantages over horizontal systems as mentioned  
15 above, they do carry their own inherent drawbacks. Access of cranes and other lifting equipment to the pipe being laid, once it has passed into the tower and to the area around the base of the tower, is prevented by the simple presence of the tower, tensioner, winch and so forth. Should the need arise to adjust or even move the article being laid only the lifting equipment provided on the tower can be utilised. It is often  
20 desired to use the moonpool for other purposes when not laying pipes. EP-A-0717221 shows a tower open at its base, in which skidding access is provided for uncovering heavy tools and modules, diving bells etc over the moonpool. This then requires a lifting operation by the winch in the tower, to lower the equipment through the moonpool. Finally, it is often a requirement to add equipment such as buoyancy  
25 modules to a pipe during laying operations. It would be desirable to be able to lift such additional equipment directly to the moonpool area without interference from the lay tower and tensioner.

The present invention is concerned with providing apparatus and a method for laying of  
30 elongate articles in which the above mentioned problems are overcome or in the least alleviated. The object of the present invention is to provide apparatus and a method of laying elongate articles in which the access to the base of the tower and any elongate article being laid is improved.

In accordance with the present invention there is provided apparatus for laying elongate articles on the sea-bed from a vessel, which apparatus includes a radius controller and, at least one track tensioner supported above the deck of the vessel, the apparatus  
5 defining a laying path such that during laying an elongate article passes over the radius controller and then downwardly through the tensioner to enter the sea in a predetermined entry region relative to the vessel, the tensioner supporting the weight of the elongate article between the vessel and the sea bed, wherein the path defined through the tensioner for laying is inclined at an angle to the vertical and the tensioner  
10 is located away from a point directly above said entry region, and wherein the apparatus further includes first and second guide means moveable independently in the plane of inclination of the laying path, each adapted for supporting the elongate article at a point between the tensioner and the entry region to avoid interference of the elongate article with the vessel.

15  
In one arrangement of the invention the radius controller and the tensioner may be located in a tower. The inclination of the lay path and the location of the tensioner away from the vertical in this case should be sufficient to allow the side and top of the tower to be exposed with a suitably open framework or lattice structure for the tower,  
20 and thereby open up access for the cranes and other lifting equipment on the vessel to the interior of the tower. Specifically access will be enabled to the base area of the tower and the pipe or other elongate article being laid above the entry region. The two guide means can be independently retracted and engaged to the elongate article being laid in turn, to allow passage of the crane or working on the elongate article. This will  
25 also allow passage of the coupling and other accessories without undue local strain. Both can be retracted for the deployment of equipment when the vessel is not laying pipe via the moonpool.

The entry region may be defined by a moonpool, or may be a region to the side of the  
30 vessel. In one arrangement, the tower is located on the deck of the vessel adjacent to a moonpool so that there is minimum overlay of the tower either over the moonpool. For clarity by using the term moonpool reference is being made to any means within the confines of the deck of the vessel that provides access directly to the sea, such as

vertically through the hull of a vessel. With regard to the moonpool type of arrangement the tower need not straddle and cover the moonpool, but may be located adjacent to one side of the moonpool so that it overhangs the moonpool giving access either through the tower or around the tower to the moonpool.

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The guide means, or at least one of them, may comprise a guide track arrangement so as to present a support surface which moves with the elongate article as it is laid.

10 The guide track arrangements may comprise a short arcuate section with articulated track running over the surface of the arcuate section.

The arrangement with the short arcuate section has the advantage of allowing a large apparent radius to be provided for the guide tracks in a relatively small space. In one arrangement the guide means are vertically spaced apart and disposed below the  
15 tensioner. One of the guide means may be located above deck and the other below the height of the deck. For example, one of the guide means may be located below the tensioner but within the confines of the tower and the second guide track located below the height of the deck within the moonpool or vessels side.

20 Each of the guide means may be mounted with hydraulic ram arrangements so that they can be moved independently to engage or disengage the elongate article. Other drive arrangements, be they electric, pneumatic or whatever, can also be envisaged.

In accordance with a second aspect of the invention there is provided a method of  
25 laying elongate articles from a vessel using apparatus located on the deck of the vessel, which apparatus includes a radius controller, at least one track tensioner supported above the deck of the vessel, and first and second guide means, the apparatus defining a laying path for the elongate article that is inclined to the vertical, said first and second guide means being moveable independently in the plane of the of the laying path,  
30 wherein the method includes the steps passing the elongate article over the radius controller, and downwardly through the tracks of the tensioner, and into the sea in a predetermined entry, independently moving the guide means to engage the elongate

article and guide the elongate article during laying so that it does not interfere with the vessel.

## 5 BRIEF DESCRIPTION OF THE DRAWINGS

An embodiment of the apparatus of the invention, and a method of operating the invention, will now be described, by way of example only, by reference to the accompanying drawings, in which:

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Fig 1 shows a vessel including apparatus made in accordance with the present invention:

Figs 2 to 12 illustrate steps in the operation of the apparatus as shown in

Fig 1; and

15

Fig 13 shows an alternative arrangement for the apparatus as adapted for use over the side of the vessel.

## DETAILED DESCRIPTION OF THE EMBODIMENTS

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Referring to Fig 1 of the drawings there is shown a vessel 1 suitable for laying cables, rigid pipes, flexible pipes or umbilical pipes at sea. The vessel 1 includes a rear mounted rigid pipe laying tower 2 for laying over the stern of the vessel, a storage hold 3a for storing sections of rigid pipe 100a, a storage hold 3b for storing a drum or carousel of cable or flexible pipe 100b, a number of cranes or other lifting means, a moonpool 4 through the body of the vessel, and a second laying tower 5 provided adjacent the moonpool 4 for laying flexible pipe from the carousel in accordance with the present invention.

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The present invention will be described in detail with reference to Figs 2 to 12 of the drawings which illustrate the laying operation for a flexible pipe using the present apparatus. The second laying tower 5 which in this example is suitable for the laying of flexible pipes, cables and umbilical pipes through the moonpool 4 is located adjacent

the moonpool 4 so that it partially overhangs the moonpool but does not straddle the moonpool 4.

The tower 5, as shown in figures 2 to 12, comprises an open framework structure 10 and includes a main body 11, a radius controller 12 mounted at the upper end of the main body and slideably moveable thereon, a winch and lifting arm arrangement 13 also mounted at the upper end of the main body 11 and a base frame 18 to which the lower end of the main body 11 is attached. A track tensioner 14, in this example having 4 tracks, is located in the main body of the tower 5 and first and second track guide means 15 and 16 respectively are located below the tensioner. The first track guide means 15 is located below the tensioner 14 and within the confines of the tower 5, in this example the base frame 18, and the second track guide means 16 is located below the tower with in the moonpool 4. The radius controller 12, the tensioner 14, and the first and second track guide means 15 and 16 define a laying path for the flexible pipe or cable which is inclined to the normal vertical of the vessel. In this particular example of the invention the main body 11 of the tower 5 reflects the inclination of the laying path and is itself inclined so that the vertical axis thereof is inclined to the normal.

The inclination of the laying path as reflected in this example is such that the upper section of the main body 11 is horizontal spaced further away from the moonpool than the base. The base of the main body 11 also overhangs the moonpool 4 in this embodiment.

The arrangement of the tower 5 in this manner horizontally displaces the equipment in the tower and on the laying path with respect to the moonpool 4. This in turn improves the access of lifting equipment on the vessel, such as the cranes, to the area below the tensioner 14 and in the moonpool, see the description of Fig. 8 below.

The tensioner used in this example is a four-track tensioner, however in an alternative arrangement the caterpillar tensioner may be a 2 or 3-track tensioner or further a self-supporting tensioner on a boom may be used. The choice of the tensioner may depend on the actual operation of the tower and the type of elongate articles being laid.



The two guide tracks 15 and 16 provided in this example the guide tracks 15,16 each comprise a short arcuate section with articulated caterpillar track, and the tracks are driven by the pipe or cable as it is being laid. Each of the guide tracks 15 or 16 is provided with hydraulic locating means and is movable in the plane of inclination of the laying path and for this example the tower 5. Thereby the track guides 15 and 16 are moveable in and out of engagement with the pipe being laid.

The provision of the guide tracks 15, 16 with a short arcuate section rather than a full wheel, as used in the past, reduces the space occupied by the guide track. Further, the radius given to the arcuate section can be increased over what would be the case if a full wheel was provided with all the advantages that this provides.

A winch 17 is further provided on the deck on the opposite side of the moonpool 4 to the tower 5.

Figures 2 to 12 of the drawings show steps in the operations on the vessel during the laying of a flexible pipe therefrom using a tower in accordance with the present invention.

Referring to Fig 2 of the drawings a section of pipe 100 having an appropriate end connection 101 is fitted with a guide wire 103. The guide wire 103 is run over the radius controller 12 and down centre of the main body 11 between the tracks of the caterpillar tensioner 14. The wire is then wound around a pulley or deflector sheave 17a to the winch 17.

The end connection 101 and the end of the attached section of pipe are lifted by the vessel's crane as the winch 17 winds the wire 103 in. The position of the radius controller 12 on the tower may be adjusted to provide the optimum lifting position and ensure that the wire or flexible pipe is centred in the tensioner, and to allow the radius controller to be withdrawn to allow the clear passage of end terminations.

The end of the section of pipe 100 is located on the radius controller 12 and the wire wound in drawing the end connection over the radius controller 12. The end connection 101 is then passed through or around the open tensioner 14 and the pipe 100 disposed between the tracks of the tensioner 14. The position of the radius controller 12 on the tower 5 may be adjusted to facilitate this and is moved into the optimum position for the laying of the pipe 100.

The section of pipe 100 is now lowered through the tower 5. When the end of the section of pipe 100 has been lowered sufficiently through the tower 5 the upper guide track 15 is moved into position and engages the pipe (see Fig 3) and the tracks of the tensioner 14 closed to grip the pipe 100. With the tensioner taking the weight of the pipe being laid the guide wire 103 is disengaged.

The pipe 100 is now lowered under the action of the tracks on the tensioner 14, this in turn drives the articulated caterpillar track on the guide track 15. When the end of the pipe 100 has been lowered sufficiently the lower guide track 16 is moved into position against the pipe 100 centring the pipe 100 in the middle of the moonpool 4 (see Fig 4). The articulated track on the lower guide track 16 is driven in the same way as the track is driven on the upper guide track.

The pipe 100 is lowered towards the sea-bed until the other end of the pipe 100 with a second end connection 102 in place nears the tower 5. A messenger wire M is attached to the end connection 102 and the crane is used to lift the end connection over the radius controller 12 as the pipe is further lowered. The lifting arrangement 13 on the tower 5 is connected to the end connection 102 (see Fig5) and the upper guide track 15 withdrawn. The radius controller 12 is withdrawn and the tracks of the tensioner 14 disengaged from the pipe section 100 (see Fig 6). The upper track guide 15 is also withdrawn.

The load of the pipe 100 is taken by the lifting arrangement 13 and the pipe 100 lowered with the lower guide track 16 in position engaging the pipe 100. The end connection is then hung up on the doors to the moonpool 4.

As shown in Fig 7 a table 200 is provided so that the end connection 102 of the laid pipe 100 can be hung up above the moonpool doors. The table 200 comprises a tubular structure with a base section that engages the deck of the vessel and an upper section which supports the weight of the laid pipe 100. The upper section of the table 200 is angled so that the end connection bears against it and is maintained in the correct orientation to facilitate the connection of a second section of pipe to the first. This has advantages relative to pipe arrangements, in which the connection 102 is hung at the level of the moonpool doors. Firstly, the lower guide track can be used mounted higher in the moonpool. Secondly, the table connection is at a more convenient height for workers at the deck.

A second section of pipe 100 is now lifted into place about the radius controller 12 as with the original section of pipe 100 and as described above. The tracks of the tensioner 14 are closed about the pipe to grip it and the new section of pipe gently lowered. The end connection 101 of the second pipe section is thereby lowered and located in the end connection 102 of the first section of pipe. Laying of the pipe is now readily to recommence.

To restart laying of the pipeline the lower guide track 16 is withdrawn and the upper guide track 15 is moved into position against the pipe 100 (see Fig 8). As the pipe is now run out the lower guide track 15 is moved back into position against the pipe 100 (see Fig 9).

In this way the pipe 100 is assembled from sections by repeating the steps mentioned and detailed above. When the pipeline formed from the sections of pipe 100 nears completion and the final connection of the end connections 101 and 102 has been made the pipe is laid as with before completion of the laying operation may commence. The procedure as illustrated above is followed with connection of the messenger wire etc. Whereas the pipe would be lowered and the end connection hung up on the moonpool 4 doors if a further section of pipe was to be connected, the pipe is now lowered through the moonpool 4 (see Fig 10). The upper track guide 15 is moved to engage the messenger wire M and the lower track guide 15 disengaged to allow for passage of the end connection thereby.

Once the end connection 102 of the pipe has passed the lower track guide 16 this track guide 16 is moved back into position and engages the messenger wire M (see Fig 11). This centralises the pipe being lowered in the moonpool 4. The pipe 100 is lowered to the sea-bed and then disengaged in the normal manner (see Fig 12). This pipe section 100 may be connected up to other equipment or another section of pipe as is required in line with normal operational procedures.

The above example is given as an example of the operation of the present invention so that it may be more readily understood, it is not intended to provide any specific limitation on the invention to be claimed and should be read and considered in this light.

Now referring to Fig 13 of the drawings there is shown a second embodiment of the invention. In this example the apparatus is very similar to that described above with regard to Figs 1 to 12 of the drawings and like numbers have been used to describe like components. However in this example the apparatus has been adapted for use over the side of the vessel.

In this instance the tower 5 overhangs the side of the vessel for example being located on a platform over the side of the vessel. The winch 17 is located on the deck of the vessel with the sheave 17a located so that the line of pulling force from the winch is directed substantially along the laying path. The second track guide 16 is located against the side of the vessel. The table 200 for hanging up of the end connections 102 to enable the connection is still provided and may located on the platform in a suitably location.

The operation of the tower for the laying of pipe is substantially as with that described for the moonpool example given above.

**Claims**

1. Apparatus for laying elongate articles on the sea-bed from a vessel, which apparatus includes a radius controller and, at least one track tensioner supported above  
5 the deck of the vessel, the apparatus defining a laying path such that during laying an elongate article passes over the radius controller and then downwardly through the tensioner to enter the sea in a predetermined entry region relative to the vessel, the tensioner supporting the weight of the elongate article between the vessel and the sea bed, wherein the path defined through the tensioner for laying is inclined at an angle to  
10 the vertical and the tensioner is located away from a point directly above said entry region, and wherein the apparatus further includes first and second guide means moveable independently in the plane of inclination of the laying path, each adapted for supporting the elongate article at a point between the tensioner and the entry region to avoid interference of the elongate article with the vessel.  
15
2. Apparatus as claimed in claim 1, wherein the radius controller and the tensioner are located in a tower.
3. Apparatus as claimed in claim 1 or claim 2, wherein the tower has an open  
20 framework or lattice structure and the inclination of the lay path and the location of the tensioner away from the vertical is sufficient to allow the side and top of the tower to be exposed, and thereby open up access for the cranes and other lifting equipment on the vessel to the interior of the tower.
- 25 4. Apparatus as claimed in any preceding claim, wherein the two guide means can be independently retracted and engaged to the elongate article being laid in turn, to allow passage of the crane or working on the elongate article.
5. Apparatus as claimed in any preceding claim, wherein the tower is located on  
30 the deck of the vessel adjacent to a moonpool so that there is minimum overlay of the tower over the moonpool.
6. Apparatus as claimed in any one of claims 1 to 4, wherein the tower is located to overhang the side of a vessel.

7. Apparatus as claimed in any one of the preceding claims, wherein the guide means, or at least one of them, comprises a guide track arrangement so as to present a support surface which moves with the elongate article as it is laid.

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8. Apparatus as claimed in claim 7, wherein the guide track arrangement(s) comprise a short arcuate section with articulated track running over the surface of the arcuate section.

10 9. Apparatus as claimed in any of the preceding claims, wherein one guide means is located above deck and a second guide means is located below the height of the deck.

10. Apparatus as claimed in claim 9, wherein, one of the guide means is located below the tensioner but within the confines of the tower and the second guide track  
15 located below the height of the deck within the moonpool or over the vessel side.

11. Apparatus as claimed in any one of the preceding claims, wherein each of the guide means is mounted with hydraulic ram drive arrangements so that they can be moved independently to engage or disengage the elongate article.

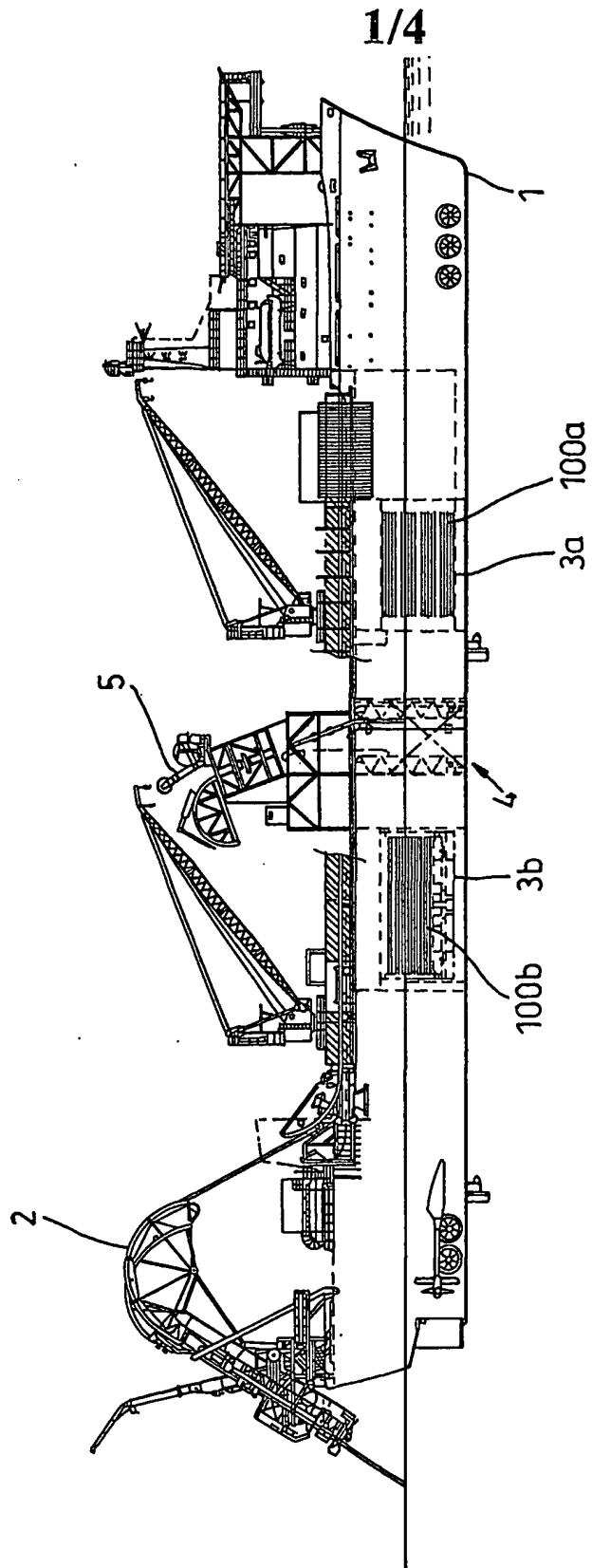
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12. Apparatus as claimed in any one of claims 1 to 10, wherein each of the guide means is mounted with pneumatic drive arrangements so that they can be moved independently to engage or disengage the elongate article.

25 13. Apparatus as claimed in any one of claims 1 to 10, wherein each of the guide means is mounted with electric drive arrangements so that they can be moved independently to engage or disengage the elongate article.

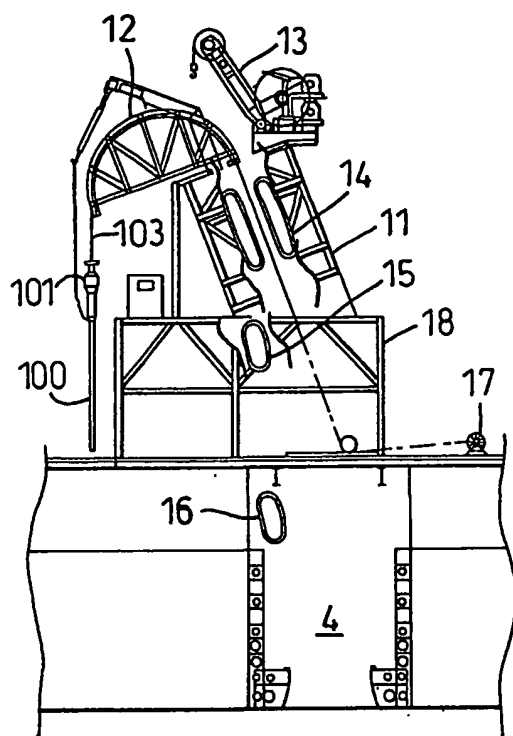
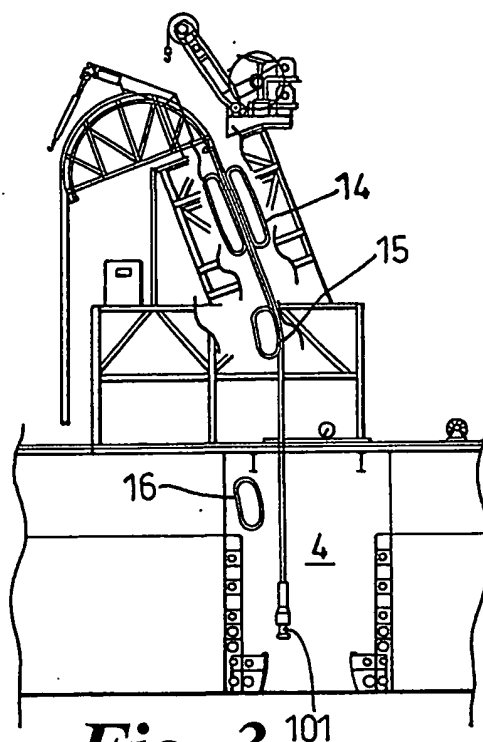
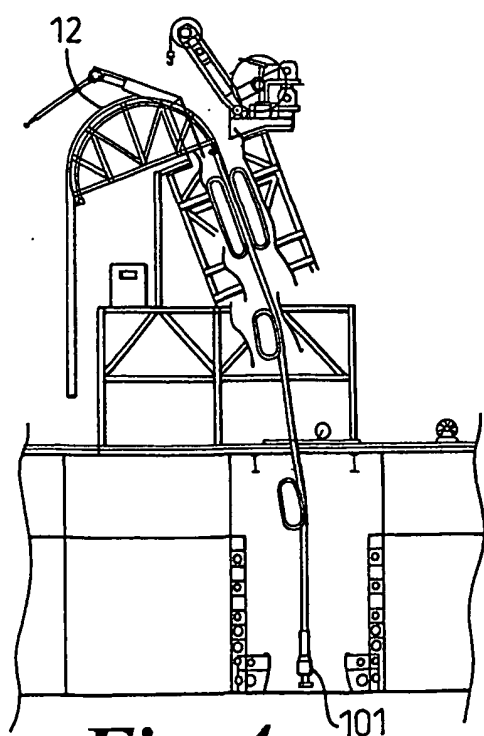
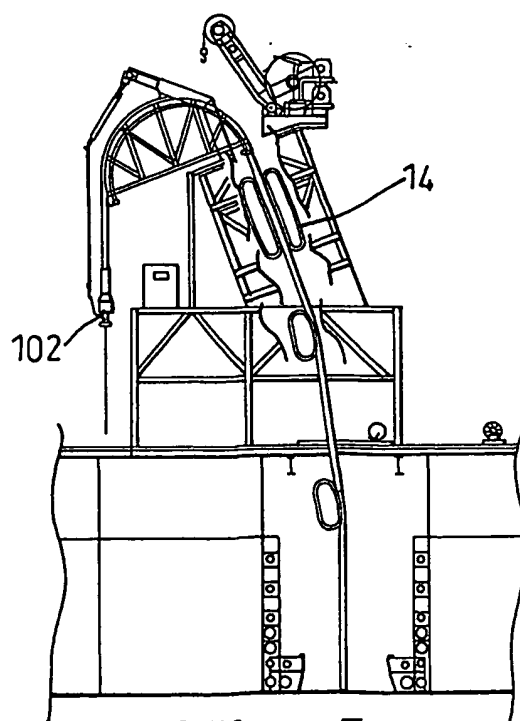
14. A method of laying elongate articles from a vessel using apparatus located on  
30 the deck of the vessel, which apparatus includes a radius controller, at least one track tensioner supported above the deck of the vessel, and first and second guide means, the apparatus defining a laying path for the elongate article that is inclined to the vertical, said first and second guide means being moveable independently in the plane of the of

the laying path, wherein the method includes the steps passing the elongate article over the radius controller, and downwardly through the tracks of the tensioner, and into the sea in a predetermined entry, independently moving the guide means to engage the elongate article and guide the elongate article during laying so that it does not interfere  
5 with the vessel.

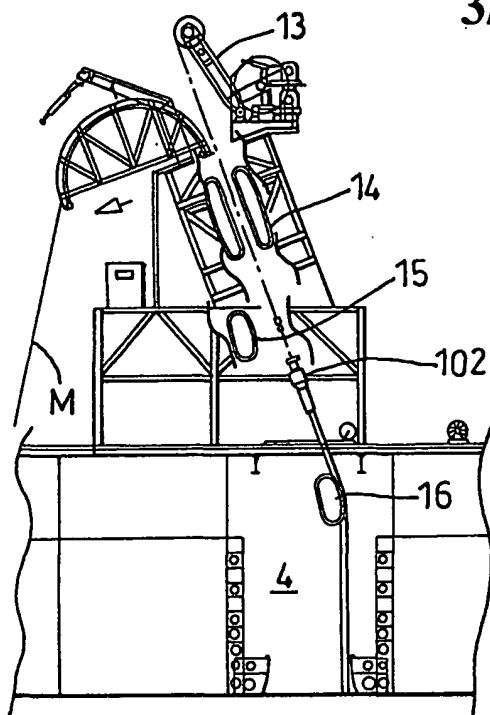




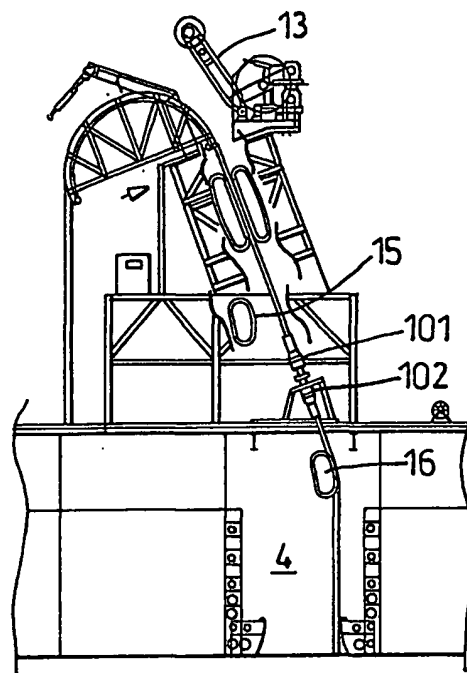
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**Fig. 2****Fig. 3****Fig. 4****Fig. 5**

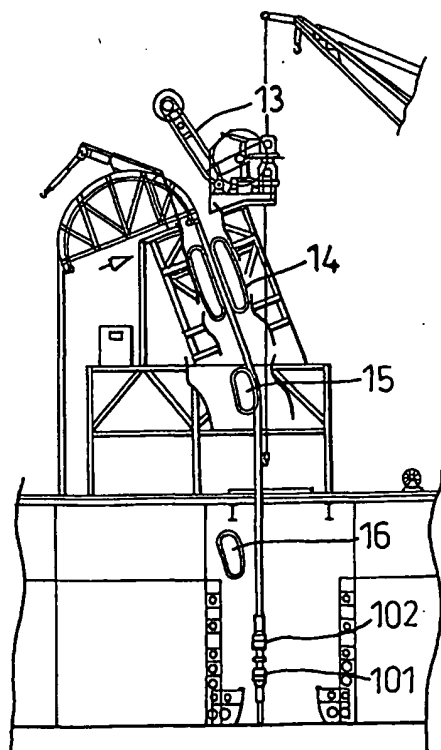
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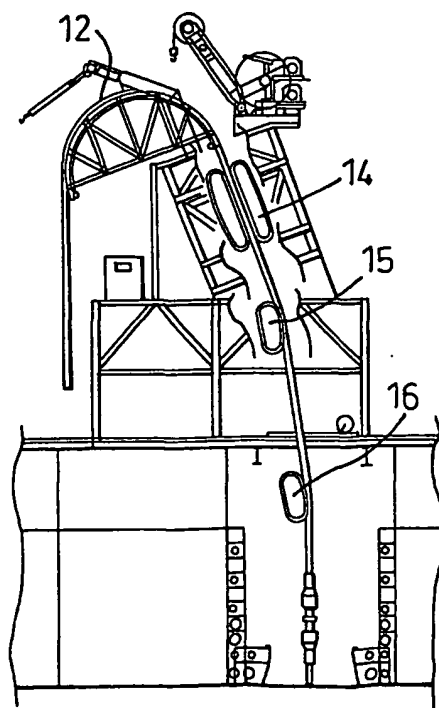
**Fig. 6**



**Fig. 7**

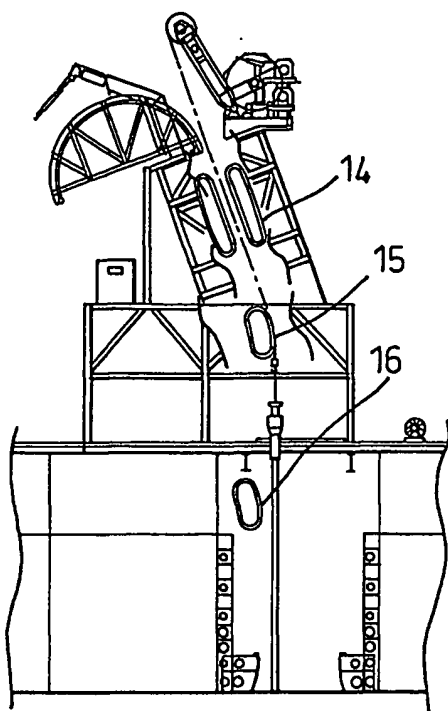


**Fig. 8**

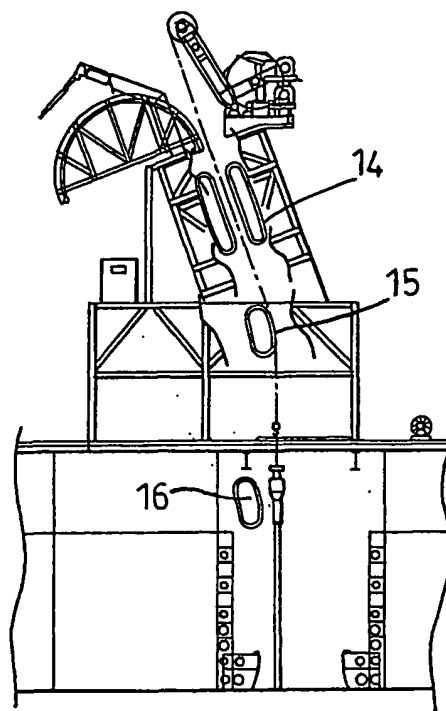


**Fig. 9**

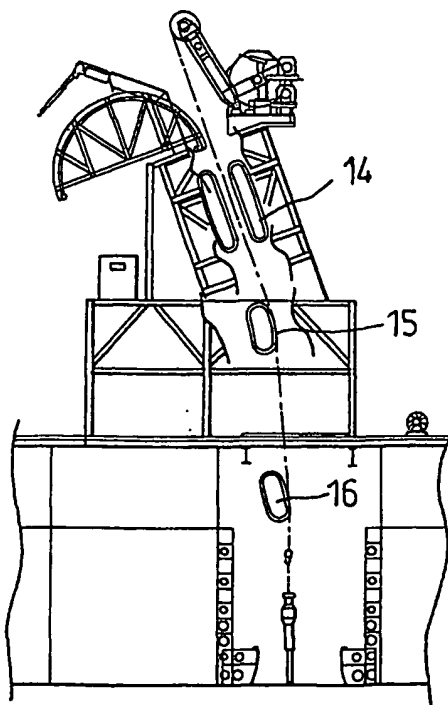
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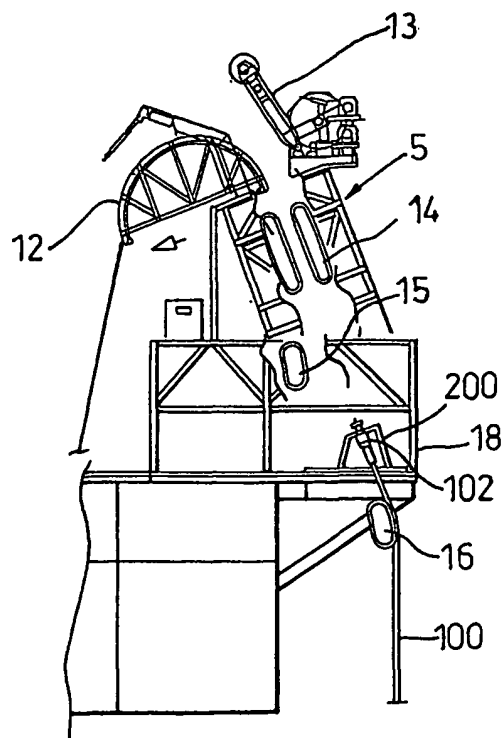
**Fig. 10**



**Fig. 11**



**Fig. 12**



**Fig. 13**

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 02/00200

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 F16L1/19 F16L1/23

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F16L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	GB 2 303 897 A (COFLEXIP) 5 March 1997 (1997-03-05) figures 1,4A,5A	1,14
A	US 5 348 423 A (MALOBERTI RENE ET AL) 20 September 1994 (1994-09-20) cited in the application figures 1,2A,3A	1,14



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Patent family members are listed in annex.

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Date of the actual completion of the International search

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

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